Chapter 9

Treatment of Acneiform Eruptions, Acne and Acne Scars with Surgery, Lasers and Light-Based Devices

Erol Koc and Asli Gunaydin Tatliparmak

Additional information is available at the end of the chapter

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Abstract

Acne is a common skin disease that affects pilosebaceous unit, and it is characterized as comedones, inflammatory papules, pustules and occasionally nodulocystic lesions. Acne scar lesions have adverse effects on psychosocial life despite the latest treatment options.

Keywords: acne, eruption, laser, scar treatment

1. Treatment of acne with surgery.

Although acne surgery term is used for acne scar treatment methods, it could also be used in active acne lesions to support medical therapy. Surgical therapy is used to minimize inflammation and scar risk and to fasten the healing. Below are four categories of active acne lesions for surgical therapy guidelines [1]:

- Grade 1 (comedonal acne)
  - Comedone extraction
- Grade 2 (inflammatory papules)
  - Cryotherapy
  - Laser and light therapy

- Grade 3 (inflammatory pustules)
  - Cryotherapy
  - Nonablative lasers
  - Light therapy
- Grade 4 (nodulocystic acne)
  - Incision/drainage
  - Intralesional corticosteroids
  - Cryotherapy

1.1. Comedone extraction

Comedone extraction is a method where the clogged content in pilosebaceous unit is mechanically drained using a comedone extractor.

After wiping the surface with alcohol, comedone extractor is centered over the comedone and pressure is applied to the direction of hair follicle to drain the contest. If closed comedones present a small hole on the surface of the lesion, they should be opened by 21 gauge needles to make the extraction less traumatic.

The important considerations in the extraction process to minimize the risk of scarring and inflammation are to avoid applying undue pressure and pay attention to antisepsis rules [1, 2].

1.2. Cryotherapy

Cryotherapy can be applied with cryoslush or cryopeel methods in nodulocystic acne. In cryoslush method, crushed carbon dioxide and a few drops of acetone are added to make a paste. This paste is spooned on the lesions for 2–10 s with a gauze ball. It consists of superficial peeling effect due to epidermal necrosis, which causes desquamation of comedones and resolution of inflammatory lesions. The degree of peeling effect is determined by the amount of time the slush contacted with the lesions [3].

In the cryopeel method, liquid nitrogen spray is applied to lesions for 2–3 s. However, the risk of postinflammatory pigmentation (hypo or hyper), persistent erythema and scarring should be noted with this method. In particular, the patients with Fitzpatrick skin type 4–5 have greater risk of pigmentation and scar formation [1].

1.3. Incision/drainage/aspiration

Incision/drainage/aspiration of the cystic lesions can be applied with or without phenolization. After surgical cleaning of the area, a small incision is made with a no.15 surgical blade and cysts are drained. After draining, cyst wall is chemically cauterized with 88% phenol applied swab stick and neutralized with povidone-iodine to prevent from recurrence. Intralesional and perilesional triamcinolone acetonide 5–10 mg/ml is injected to reduce the risk of fibrous scarring in some cases [1, 2].

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1.4. Intralesional corticosteroids

Intralesional corticosteroids are used in nodular and cystic acne patients to reduce the inflammation and minimize scarring. Triamcinolone acetonide is diluted with lidocaine 1% or sterile water to obtain 2.5 mg/ml concentration.

If the lesion is tensed, it should be drained before the injection. Injection is repeated after 3 weeks if there is an incomplete resolution. Hematoma, infection, atrophy and hypopigmentation are the complications that can be seen after the treatment [1, 4, 5].

2. Treatment of acne with lasers

2.1. Infrared lasers

Near-infrared (IR) light (700–1000 nm) penetrates deeper dermis than the red light. And during this penetration, it makes a minimal effect on the epidermis. This wavelength targets the tissue water in sebaceous glands and reduces the sebum secretion by thermal damage.

Infrared lasers (1064, 1320, 1450, 1540 nm) are generally used in facial skin rejuvenation, but there are also literatures showing reduction in the inflammatory acne lesions [6].

2.2. Pulse dye laser

Pulse dye lasers are nonablative, 585–595 nm wavelength systems that target the oxyhemoglobin in microvessels. They are generally used in the treatment of vascular lesions. The mechanism of action in acne treatment is still unknown, and the respond rates range between 40 and 49% [6–8]. Pain and postinflammatory hyperpigmentation are the most common adverse effects. The risk of discoloration is higher in patients with Fitzpatrick type IV and V skin. The treatment parameters are 4–7.5 J/cm^2 fluence, 350 μs to 6 ms pulse duration, and 585 or 595 nm wavelength [6, 7].

2.3. Potassium titanyl phosphate laser

Potassium titanyl phosphate lasers (KTP) are the laser devices with 535 nm wavelength and often used in the treatment of rosacea and telangiectasia. Response rates ranging from 32 to 20% have been reported with 1 or 2 time sessions per week.

The mechanism of action may be related to the destruction of blood vessels or laser-stimulated photodynamic reaction. Before the treatment, the use of aminolevulinic acid (ALA) as a photosensitizer response rate rises to 52% [6, 9].

3. Treatment of acne with light-based devices

Use of light-based devices for acne is based on the effect of photoabsorption of porphyrin produced by *Propionibacterium acnes*. This basic pathogenic Gram-positive bacterium in acne

produces porphyrin, and when this substance absorbs the light, it reveals highly reactive oxygen radicals and leads to death of bacteria.

Porphyrin has two photo absorption peaks. The highest absorption is seen in the middle of blue light wavelengths in other words at Soret band, 415 nm. The second major absorption peak occurs at 630 nm, red light [10]. Red light has less effect on the activation of porphyrin; however, it reaches deeper into the skin, and by this means, it may lead to direct effect on inflammatory mediators [11].

3.1. Intense pulsed light (IPL)

IPL is an intense pulsed light system used in a number of dermatological cases such as vascular lesions, acneiform eruptions, pigmentary diseases, premalignant lesions and adnexal diseases. In the single pulse mode, the fluence will be delivered in single mode, and in burst mode, the fluence will be divided into series of pulses. It works in single pulse mostly, and pulse duration identifies energy output. However, in one of the study reports, 56% of reduction was achieved in acne scores in burst mode, and this rate was reported as 40% in the single pulse mode [9, 10].

It is considered that IPL has an impact by means of photoactivation of porphyrin secreted by *P. acnes*. Free oxygen radicals as a result of this photoactivation reduce production of sebum from sebaceous glands.

At the same time, it was shown that suppression of IL-8 and TNF-alpha production has a significant role in inflammatory acne pathogenesis and increased expression of IL10 has an anti-inflammatory effect [12]. In the studies conducted, it was reported that IPL was especially effective for inflammatory acne lesions. Safe use for skin type 3–4 patients is one of the advantages of IPL.

Recently, application of vacuum IPL to target pilosebaceous unit better has came into question. It was indicated that vacuum apparatus would reduce the debris in pilosebaceous unit and offer the opportunity of easier application in curled regions such as nose and forehead sides. However, risk of transient mild erythema is higher in vacuum IPL [6].

3.2. Narrowband blue light

Ultraviolet (UV) radiation has a therapeutic effect in inflammatory acne. This effect is considered as related to follicular Langerhans cell suppression and destruction of *P. acnes*.

Blue light is in 400–500 nm wavelength and can penetrate into upper epidermis. Light with such wavelength inhibits keratinocyte inflammation and also results in mitochondrial damage in nonpigmented epithelial cells and creates toxic effect. It slows down proliferation of keratinocyte in pilosebaceous unit. Anti-inflammatory effect on keratinocyte occurs by reducing IL-1 and ICAM markers. As stated before, when porphyrin produced by *P. acnes* absorbs light, it produces free oxygen radicals being toxic for the bacteria [13, 14].

Rate of response to the treatment was reported up to 77% in moderate inflammatory acne. Administration dose in the studies varies between 2 and 29 J/cm^2 for the inhibition of occurrence of new lesion or to prevent inflammation in the active lesion [6, 9].

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3.3. Narrowband red light

Red light can penetrate into sebaceous glands in dermis (620–660 nm). Its basic effect is the activation of protoporphyrin IX and reducing release of inflammatory cytokine. Although it penetrates deeper than blue light, higher concentration light is necessary for *P. acnes* eradication.

It reduces inflammation in inflammatory and noninflammatory acne; however, it cannot achieve resolution completely. For this reason, it should be used in combination with ALA, not alone [6, 15].

3.4. Blue-red light-emitting diode

Blue-red light is more effective for the treatment of inflammatory acne alone than blue (415 nm) or red light (630 nm). Reported rates of response to treatment vary between 77 and 90%. Blue-red light achieves 34–54% reduction in noninflammatory acne lesions. Synergic effect of combined treatment was observed as decrease in cell proliferation in in vitro cultured sebaceous cells and lipogenesis [6, 16].

Phototherapy is administered to the patients 1 or 2 times a week for 15–20 min totally for 4 weeks, and it is reported that efficiency of the treatment lasts for average 8 weeks more [16].

3.5. Photodynamic therapy

When photosensitizing agents are applied to acne lesions, protoporphyrin IX production by *P. acnes* increases and free oxygen radicals appear. These free oxygen radicals damage mitochondria, nucleus and cell membrane and create cytotoxic effect on *P. acnes*.

A number of light sources were used in photodynamic therapy (PDT) with varying success rates. All light sources may lead to erythema, stinging, peeling, oozing, pruritus and pustule formation [6, 9].

Aminolevulinic acid (ALA) is a photosensitizer used in PDT frequently and is transformed into protoporphyrin IX by *P. acnes* if applied to inflammatory lesions. The biggest advantages of ALA are the short duration of photosensitizing effect within 24 h and low risk of side effects due to topical usage [17, 18].

There are a number of variations related to ALA-PDT combination. Some of them include the concentration of medicine used, incubation time and type of light source used (LED, IPL, red light, blue light or combined light). For this reason, an optimal therapy regime is not applicable for PDT in acne treatment.

Before starting ALA-PDT treatment, it should be proven that basic bacterium in the lesions is *P. acnes* because the response to the treatment depends on the presence of *P. acnes*. For this reason, lesional skin should be examined with wood lamp before the treatment and it should be examined whether spontaneous fluorescence is positive or not [17].

One of the most significant parameters determining the treatment response is which light source will be used. While depth of sebaceous glands in the skin is ≤2 mm, it is deeper than 2 mm in elevated acne papule or pustule. For this reason, wavelengths affecting deeper should be used [8, 17].

Success rate was reported as 68–95% in PDT with red light. Success rate of PDT with blue light is 7–21% better than blue light alone. However, ALA-PDT with blue light has relatively shorter effectiveness and longer side effect profile [6, 8].

4. Treatment of acne scars with surgery

Acne scars vary from superficial rolling scars to deep ice pick and boxcar scars due to their morphology and depth. Most of the patients have more than one type of scars. Atrophic scars are grouped as ice pick, boxcar and rolling scars and those characterized with collagen over-production are grouped as hypertrophic and keloid scars [17]. While selecting the treatment, acne scar type and duration of the disease should be considered. Previous treatments, keloid history, past or active herpes simplex infection, habit of smoking and sun exposure should be questioned certainly.

If the patient has HSV infection history, acyclovir or famciclovir treatment should be started 2 days prior to the procedure and carried on 7–10 days after the procedure. Informed consent form should be obtained from every case, and if possible, pre- and posttreatment photographs should be taken.

Surgical treatment options for acne scars are subcision, punch excision, dermabrasion, filling, intralesional steroid injection, silicone gel coating and scar revision [4].

4.1. Subcision

The purpose of this treatment is to break down the fibrotic bands connecting the scar to the subcutaneous tissue. It is mostly preferred for rolling scars.

Firstly, scar area is marked with a pen. Then, local anesthesia is applied, and 18 or 20 gauge needle is proceeded to deep dermis parallel to the border of the scar marked.

It is continued along the border marked, side-to-side needle motion called 'fanning motion' is applied, and fibrous bands are made free. There are publications in the literature, indicating that better response (50% cure rate) is achieved with 18 and 21 gauge cannula [19]. The doctor should be more careful in preauricular, temporal and mandibular regions because of the placement of facial nerve branches and major arterioles.

'Blunt blade subcision' is also another technique for the treatment of atrophic acne scars. The authors hypothesized that using a blunt blade reduces the risk of trauma of neurovascular structures.

After local anesthesia, 18 gauge needle is used to puncture the entrance of the blade. Up to three-fourths of the blade could enter into the skin, and the blade should be moved back and forth subdermally to release the fibrotic tissue [20, 21].

4.2. Punch excision techniques

These techniques are used for depressed scars such as ice pick and boxcar. There are punch excision types varying in the diameter and surface of the scar:

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I: Punch excision and closure: If the scar is bigger than 3–5 mm, it is excised to subcutaneous fat layer firstly and sutured after undermining. The doctor should be careful to avoid new scar formation.

II: Punch incision and elevation: If the depressed scar has a normal surface structure, it is incised to subcutaneous tissue (incised up) and elevated to the level of peripheral tissue.

III: Punch excision and grafting: Depressed pitted ice pick scars with the diameter of 4 mm are excised and then placed into autologous, full layer punch grafts. Donor sites are mostly post-auricular site or hip [2, 4, 5].

4.3. Dermabrasion

Dermabrasion is the peeling of skin from epidermis to dermal layers to the level desired by use of electrical dermabrader. Manual dermabrader is used only for spot dermabrasion.

Re-epithelialization starts from the border of scar and sebaceous gland, sweat gland and hair follicle residuals. Since facial area is rich of these glands, recovery is faster than other regions.

Spot dermabrasion is applied under local anesthesia and at outpatient clinic; however, full-face dermabrasion should be performed in the hospital where we have the opportunity of immediate intervention. After the consent of the patient is obtained, the treatment area is cleaned, local anesthesia is done, and scars are marked. Dermabrasion is applied to the marked regions. Dermabrasion should be applied to maximum upper and midreticular dermis joining region to prevent postprocedure formation.

Wider bleeding focus, firmer surface and parallel line and break in grooves are observed in this joining region. According to the depth of dermabrasion, crusting starts within 7–10 days. Infection, persistent dyschromia, hypo-/hyperpigmentation, erythema and scarring are the complications.

Even if dermabrasion remains in the background after ablative lasers started to be used, it is still an efficient option for properly selected patients [1, 2, 5].

4.4. Filling (soft tissue augmentation)

A number of fillers are used for depressed scars, and these are mainly hyaluronic acid, hydroxyapatite, collagen, tricalcium phosphate, autologous fibroblasts and silicone gel. Fillers are chosen for minimal downtime and fast response.

Dermal filler is placed under the scar and injected till the scar level becomes the same as the surrounding tissue. It can be used alone and also can be applied after subcision or ablative laser treatment [2, 5].

Hyaluronic acid is a hydrophilic polysaccharide that occurs in the connective tissue naturally. Injection of hyaluronic acid stimulates the collagen synthesis and activation of dermal fibroblasts [4].

Calcium hydroxyapatite is a semipermanent dermal filler that stimulates fibroblast production of collagen. This filler can improve the appearance of atrophic acne scars but not deeper ice pick scars [1].

4.5. Intralesional steroids

In 10–20 mg/ml dilution, intralesional triamcinolone for hypertrophic scars and keloids can be applied with or without cytotoxic agents (like 5-fluoroauracil). The procedure is repeated for 3- to 4-week period till the lesion is regressed, but risk of atrophy should be considered [1, 2].

The proposed mechanisms of action are decreased fibroblast proliferation and collagen synthesis [4].

4.6. Silicone gel sheeting

It is considered that silicon sheets are effective to correct surfaces of hypertrophic scars and keloids and reduce the discoloration [1].

Silicone provides the therapeutic effect by pressure and hydration. Silicone sheets are cut to the size of scar and should be worn for 12 h per day for 2 months [4].

4.7. Scar revision

In the selected cases, surgical techniques such as Z, M and Y plasty can be used if the scar is linear or extensive. However, the procedure should be performed by an experienced dermatosurgeon [1].

5. Treatment of acne scars with lasers

This issue will be mentioned under the headlines of ablative, nonablative and fractional lasers.

5.1. Ablative lasers

Er:YAG (2940 nm) and infrared CO_2 (10,600 nm) lasers are the treatment choices for ablative nonfractional skin resurfacing. The depth of efficacy depends on the number of passes. The energy is absorbed by the intercellular tissue water, and with this photodermal effect, neocollagenesis and collagen remodeling are stimulated. Thermal skin injury with Er:YAG laser is less than CO_2 laser. Because of this limitation of short-pulsed Er:YAG lasers, long pulses were developed.

But Er:YAG laser has still some advantages like rapid healing time and less complications compared to CO_2laser [22].

Absolute contraindications for the ablative laser treatment are as follows:

– Active cutaneous infection (bacterial, viral or fungal)

– Inflammatory skin condition (psoriasis, eczema, etc) on the treatment area

– History of keloid

– Isotretinoin use in last 6 months

After laser ablation, topical antibacterials should not be used due to risk of contact dermatitis [4, 9].

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Postinflammatory hyper- or hypopigmentation, acne flare up and erythema are the most common side effects that can be seen after ablative nonfractional laser treatments [23]. Most of the authors suggest the use of topical retinoic acid and/or hydroquinone cream to reduce the risk of hyperpigmentation [4, 22].

5.2. Nonablative lasers

The most popular nonablative lasers are Nd:YAG 1320 nm, diode 1450 nm and Nd:YAG 1064 nm lasers. These lasers deliver the energy through dermis without epidermal damage and target the tissue water. Dermal fibroblasts in the papillary and midreticular dermis are thermally stimulated leading to collagen remodeling. They have minimal postrecovery time, and this makes them safe but less effective on the atrophic acne scars than ablative lasers [23, 24].

Pulsed dye laser (PDL) has been used especially for hypertrophic, erythematous acne scars. The mechanism of effect depends on reducing transforming growth factor beta expression, fibroblast proliferation and collagen type III deposition.

The most common adverse effect of PDL treatment is purpura, which persists for several days. Edema is another side effect that can be seen but usually regresses in 48 h [9].

5.3. Fractional lasers

These lasers are classified into two categories: nonablative fractional lasers (NAFL) and ablative fractional lasers (AFL).

Fractional lasers have started to be used in 2004 firstly. These devices create vertical, cylindrical and multiple thermal damage areas called microthermal zone (MTZ) in dermis. MTZ is the zone being 1.5 mm in depth, 100–400 μm in width and having 6400 particles per square centimeter [25]. Fractional lasers are the most preferred treatment method, especially for atrophic acne scars [2]. Rolling scars are caused by subcuticular fat destruction, and they are treated with the lasers that penetrate up to the papillary dermis. Ice pick scars are narrow, deep and sharply marginated lesions.

They extend vertically to the deep dermis and do not respond well to fractional lasers. Shallow boxcar scars and most of the deep boxcar scars are amenable to fractional lasers [26].

Ablation is described as fast cellular heating and tissue vaporization during laser application. Nonablative fractional lasers have 1320–1927 nm wavelength, while ablative fractional lasers have 2940–10,600 nm wavelength.

While fractional ablative lasers are more efficient in treatment, they have longer recovery period compared to fractional nonablative lasers and higher risk of posttreatment, postinflammatory hyperpigmentation [2, 25]. Points to be considered for better response during treatment with fractional lasers are the number of passes per session and the number of sessions. While average 3–4 passes per session over four monthly sessions are preferred for fractional Er:YAG lasers, for fractional CO_2 lasers, fewer passes and sessions and longer time must be left between the treatments [2, 27, 28].

By means of intact tissue surrounding MTZ in fractional ablative lasers compared to classical ablative lasers, re-epithelialization and therefore postprocedure recovery are faster [29].

In this study, varying rates for efficiency of fractional lasers in acne scars are reported. In a review, it was reported that success rate for acne scar treatment with ablative fractional laser is varied between 26 and 83% and varied between 26 and 50% in nonablative fractional lasers [8, 30, 31].

6. Treatment of acne scars with light-based devices

Fractional radiofrequency is a new and noninvasive treatment method used for all atrophic acne scar types. When radiowave energy is transmitted to subcutaneous tissue, it will result in heating of water in skin cells, stimulation of heat-shock protein production and therefore wound healing.

Possible side effects include transient erythema, dryness, bruising, crusting and postinflammatory hyperpigmentation [2].

IPL treatment was tried for hypertrophic acne scars and keloid. Possible mechanism of action is to suppress vascular proliferation, which has a role in artificial pigmentation and collagen overgrowth. Sufficient literature about hypertrophic and keloid acne scars is not present, but in a study with 109 patients, it was reported that IPL achieved 59.7% good/excellent recovery in hypertrophic scars and keloid.

For this reason, it was claimed that IPL treatment to be started in early period after cutaneous surgical procedures prevented hypertrophic scars [32].

Author details

Erol Koc* and Asli Gunaydin Tatliparmak

*Address all correspondence to: drerolkoc@yahoo.com

Department of Dermatology, Bahcesehir University, Istanbul, Turkey

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